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DESCRIPTION OF SOME FOSSIL VERTEBRATES  
FROM THE UPPER MIOCENE OF TEXAS.

BY OLIVER P. HAY.

The fossil vertebrates described in this paper were collected by Dr. Mark Francis, of College Station, Texas, and were generously sent to the writer for examination. One collection was made on the farm of Ed. Noble, about 5 miles southeast of Navasota, about one-half mile south of Woods, on the Gulf, Colorado and Santa Fe Railroad, apparently along Walker Creek. Another collection was secured on the Jesse Garvin farm, about two and a quarter miles directly north of Navasota. The locality is between the International and Great Northern Railroad and the wagon road from Navasota to Ewing, apparently a short distance from the bench mark 305, of the map of the Navasota quadrangle. The lower jaw of a species of *Aelurodon* was found 12 miles east of Navasota and 3 miles north of Stoneham.

In securing these collections Doctor Francis had in Professor Solon N. Blackberg, of College Station, an enthusiastic assistant.

A comparison of the genera and species here described with the lists published by Mathew in 1909 (Bull. U. S. Nat. Mus. 361, pp. 112-120), and with the Snake Creek fauna (Matthew, Bull. Amer. Mus., vol. XXVI, pp. 364-365) indicates that the formation from which they came belongs near the top of the Upper Miocene or even in the Lower Pliocene.

***Ameiurus? decorus*, new species.**

In the Francis collection is the left pectoral spine of a species of catfish, belonging apparently to the genus *Ameiurus* and here described as *Ameiurus? decorus*. The specimen (pl. I, fig. 1) was found on the Garvin farm.

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It is in perfect condition, except that a little of the distal end is broken off. The original length was probably about 60 mm. The width at the middle of the length is 7.8 mm.; the thickness, 4 mm. The front edge is sharp. Immediately below this is a sharp groove; but there are no barbs on this edge. The hinder border is thickened and has two edges separated by a sharp groove. In this groove are tooth-like processes projecting but little beyond the borders of the groove, and corresponding to the barbs of existing catfish. This must have been a fish of considerable size.

#### ***Aelurodon francisi*, new species.**

The type of this apparently new species is a lower jaw lacking the ascending rami and the symphysis. The left branch contains the two hinder premolars and the three molars, all in fine condition. The hard sandstone matrix still adheres to the outer face. The left branch is practically free from matrix, but the teeth are badly preserved. The specimen was discovered in a well, at a depth of 22 feet, on the farm of J. Niscavit, on the Grimes Prairie, 12 miles east of Navasota and 3 miles north of Stoneham. On account of the finding of these bones the well was abandoned.

Fig. 1 of plate III presents a view, of the natural size, of the outside of the left ramus; figure 2, a view of the teeth seen from above. Most of the bone of figure 1 is hidden. There are two premolars and three molars, all of which are slightly worn. The length of the series is 61 mm.

Following are the measurements of the individual teeth:

	Pm <sub>3</sub>	Pm <sub>4</sub>	M <sub>1</sub>	M <sub>2</sub>	M <sub>3</sub>
Length.....	9.	12.8	24.	10.5	6.5
Width.....	6.	7.2	10.5	7.	4.6

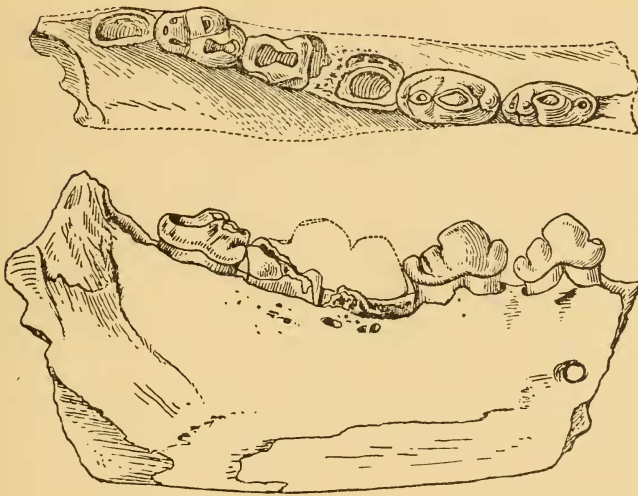
The depth of the jaw below the first molar is 28 mm.; below the third premolar, 24 mm. The thickness beneath the first molar is 15 mm.

The type of *Ae. saevus*, the genotype of *Aelurodon*, is in the U. S. National Museum. It was a larger species than *Ae. francisi*, the length of the teeth pm<sub>3</sub>-m<sub>3</sub> being close to 70 mm. The length of pm<sub>4</sub> is 15 mm.; the width, 11mm. This tooth differs from that of *Ae. francisi* in having a more prominent metaconid and a broader heel, 9.5 mm., instead of 7.5 in *Ae. francisi*. The jaw in the latter species is relatively thicker, 15.5 mm.; in *Ae. saevus*, 15 mm. In *Ae. francisi* the inner face of the jaw is flatter than in *Ae. saevus*. The premolars have anterior basal cusps. As compared with Matthew's *Ae. saevus secundus*, the two hinder premolars of *Ae. francisi* are thinner, and have a distinct paraconid and a heavy inner cingulum.

Inasmuch as this jaw was found in a deposit of sand, at a depth of 22 feet, it may be older than the other fossils.

#### ***Aelurodon simulans*, new species.**

In the collection made on the Noble farm is a part of the right horizontal ramus of a lower jaw of a dog which the writer describes under the name *Aelurodon simulans*. There are present, in fine condition, the third and fourth premolars, and the second molar; also the front socket and the hinder root of the first molar and the socket of the third molar. The crowns of the



*Aelurodon simulans*. Right side lower jaw. Upper figure. Occlusal aspect. Lower figure. Outer face.

teeth in place are little worn. At first this specimen was taken to belong to *Ae. francisi*.

The jaw presents almost exactly the part shown in the type of *Ae. francisi*. The depth beneath the first molar is 24 mm.; under the third premolar 24 mm.; under the first molar 13 mm. Following are the measurements of the teeth:

	Pm <sub>3</sub>	Pm <sub>4</sub>	M <sub>1</sub>	M <sub>2</sub>
Length.....	11.	13.4	21±	11.8
Width.....	5.5	7.	.....	7.

The teeth are in general longer and narrower than those of *Ae. francisi*; but the first molar was evidently shorter. The second molar has a longer talon than that of *Ae. francisi*, and a more developed anterior cusp. Also these cusps on the premolars are rather larger than those of *Ae. francisi*. The main cusp on the premolars have the backward pitch of other species of the genus. The diameters of the socket of the canine, just below the second premolar, are 5.4 mm. and 9 mm. In *Ae. francisi* they are 5 mm. and 7 mm.

#### **Tephrocyon scitulus**, new species.

In the Francis collection is a part of the right maxilla of a dog-like animal which is referred to *Tephrocyon*. Inasmuch as it appears not to agree with any of the known species it is described as *Tephrocyon scitulus*. The jaw was collected in the Garvin gully.

The fragment of bone contains the fourth premolar and the first molar; also the sockets for the third premolar, one of those of the second premolar

and one of those of the second molar (pl. I, figs. 2, 3). The teeth present are only slightly affected by wear. The fourth premolar is complete; the first molar has the inner border of the crown broken off.

The distance from the front of the third premolar sockets to the rear of the first molar is 38.5 mm. From the front of  $pm^4$  to the rear of  $m^1$  is 26 mm. These measurements are taken in a straight line.  $Pm^4$  is 17 mm. long, 9 mm. wide at the protocone; the paracone is 9.5 mm. high. The first molar is 11 mm. long on the outer border. Its width can not be accurately determined. On the front end the width must have been close to 14 mm. The outer border of the molar makes a large angle with the carnassial. The protocone of the carnassial projects somewhat in front of the body of the tooth and only slightly inward. On the front edge of the paracone is a very small rudiment of a protostyle. A distinct cingulum passes around the crown.

On the first molar a paracone and a metacone are well developed. A prominent ridge connects, with hardly any interruption, the protocone and the hypocone. A basin is thus enclosed. In the rear of this is a cusp which may be the metaconule. Outside of the paracone and the metacone is a heavy cingulum.

The first molar of *T. rurestris* (Merriam, Bull. Dept. Geol. Univ. Calif., vol. VII, p. 364, fig. 3) is much larger than in the species here described. In *T. hippophagus* the first upper molar is 14.2 mm. long; in *T. scitulus*, 11 mm. *T. temerarius* and *T. confertus* appear to have had the size of *T. scitulus*, but are known from lower jaws only.

Two species are here referred to the genus *Miohippus*. The generic characters appear to conform to those determined by Osborn in his Iconographic Revision. Hitherto the genus has not been found later than in the Lower Rosebud of the Lower Miocene.

#### ***Miohippus blackbergi*, new species.**

This supposed new species has for its type an upper left tooth which is taken to be the third true molar. With it is associated provisionally a part of the right ramus of the lower jaw containing two premolars and two molars. These were collected in the Garvin gully. The species is named in honor of Prof. Solon N. Blackberg, of College Station, Texas.

The upper molar (pl. I, figs. 4, 5) is wholly unworn. The following measurements in millimeters have been secured:

Length of the ectoloph.....	11.3
Height of the ectoloph.....	9.8
Height of hypocone.....	7.
Length of crown at middle of width.....	10.6
Width of crown along front border .....	13.
Width of crown along rear border.....	11.5

The ectoloph forms an angle of about 75° with the front border of the crown. The parastyle and the mesostyle are prominent and narrow. The corresponding ribs are well developed. The protoloph is interrupted by

the protoconule. There is no break in the metaloph between the hypocone and the metaconule. The metaconule has met the lamina advancing from the ectoloph, but there is a deep notch at the line of union. A similar notch remains where the protoloph joins the parastyle. The triangular hypostyle is not wholly free from the cingulum. A spur is approaching a lamina from the ectoloph and another joins the metaloph, so that the post-fossette is enclosed. There is no trace of the crochet. The anterior and posterior cingula are present; the external is feeble; the internal, obsolete.

Another upper left grinder, the hindermost, has lost the enamel of the outer face. The lophs are somewhat worn. There is no trace of the crochet. The crown is 10 mm. long.

In the fragment of the right ramus of the lower jaw are four teeth,  $pm_3$ - $m_2$  (pl. I, fig. 8; pl. III, fig. 3). The length of this series is 41.5 mm. The teeth are well worn, and they did not belong to the same individual as the molars just described. The length of the two premolars is only slightly greater than that of the two molars, but the width is greater, so that they are larger teeth.

Measurements of lower teeth in millimeters.

Teeth	Length	Width
$pm_3$	10.5	8.8
$pm_4$	10.	9.1
$m_1$	9.8	7.2
$m_2$	10.	7.1

An external cingulum is present; also a noticeable internal cingulum. In the entrance of the inner valley of the premolars and molars is a minute tubercle. A little cement is observed along the outer cingulum. There is no trace of a groove between the metaconids and the metastylids. Infolds of enamel into the areas of the protoconids and hypoconids are simple. The parastylids are well developed.

Among the loose teeth in the collection is a small, wholly unworn lower left first molar (pl. I, figs. 6, 7) which appears to belong to this species. The height is 8.2 mm.; the length 11 mm.; the width 7.4 mm. The metaconid and the metastylid are hardly separated at their summits. The hypoconulid is relatively large. There is a cingulum at each end of the crown, but none externally or internally. No root had yet developed.

This species appears to have been even smaller than Osborn's *Miohippus equinanus* (Mem. Amer. Mus. Nat. Hist., n. s. vol. II, pt. 1, p. 66, fig. 6), from the Lower Rosebud, of South Dakota. The supposed molar of *M. blackbergi* has about the same length as the first molar of Osborn's type, but it is considerably narrower. The Texan tooth appears not to be more hypsodont than those of *Mesohippus bairdi*.

***Miohippus navasotae*, new species.**

The type of this species is a single upper tooth (pl. I, figs. 9, 10) taken to be the third true molar. It is wholly unworn. The ectoloph is placed obliquely to the front border; and the inner end of the protoloph and of the

metaloph are thrown well backward. There is slight indication of cement on the crown. This tooth and those here referred to the same species were collected in the Garvin gully.

The following measurements of the type molar are taken in millimeters:

Greatest height of paracone.....	14.5
Height of protocone.....	8.5
Length of crown at middle of width.....	16.5
Greatest width of crown.....	22.

The protoloph is hardly interrupted by the protoconule and the metaloph not at all by a metaconule. There is a minute crochet. The protoloph ends within the anterior cingulum before it reaches the parastyle. The metaloph fails by a little to attain the ectoloph. On the ectoloph is a ridge beginning to reach out toward the metaloph. The hypostyle is large, V-shaped, still attached to the posterior cingulum and sending a spur toward the ectoloph. It joins the base of the metaloph, so that at an advanced stage of wear the postfossette would be enclosed. The outer styles are all well developed and the corresponding ribs are present, but inconspicuous. Front, outer, and rear cingula are present.

Among the approximately 50 lower grinding teeth of the primitive horses sent by Doctor Francis are three which appear to belong to *Miohippus navasotae*. One of these is taken to be the first or the second true molar of the left side (pl. I, figs. 11, 12). The edges of the lophs are only slightly touched by wear. Like the upper molar, the tooth is brachyodont. The total length of the crown is 21 mm. The height of both protoconid and hypoconid is 9.1 mm. The slope of these cusps is such that their summits reach the middle of the width of the crown. This width is 14.3 mm. The height of the metaconid is 8.2 mm. At a very early stage of wear the groove between this and the metastylid would disappear. The hypoconulid is large, and the prominent cingulum passes from this around the base outside to the parastylid. The roots of this tooth were not yet developed.

The two lower teeth of the right side are apparently third (pl. I, fig. 13) and fourth premolars. They are considerably worn. Each is 18.5 mm. long. The supposed third premolar is 12.6 mm. wide on the front lobe; 14.3 on the hinder. The lobes of the fourth premolar are more nearly equal in width, 14 mm. There is no groove between the metaconid and the metastylid. Except on the inner face, the cingulum is well developed.

This species is apparently not far removed from *M. gemmarosae* Osborn (Mem. Amer. Mus. Nat. Hist., n. s. vol. II, pt. 1, p. 66, figs. 46, 47) from the Lower Rosebud, of the Lower Miocene of South Dakota. In the Texas type tooth the obliquity of the ectoloph is greater than in Osborn's type; the protocone is less nearly separated from the protoconule, and the metaloph appears to join more nearly the ectoloph. At no stage of wear in *M. navasotae* would the metaloph be constricted as shown in Osborn's figures.

#### **Parahippus minutalis**, new species.

This small species is based on four upper teeth found in the Garvin gully. Two of these belong to the right side and two to the left. The writer indi-

cates these teeth by the letters *a, b, c, d*. Those having the letters *a, b*, appear to be molars. The other two may be premolars. The one indicated by *d* has lost its parastyle, and is more worn than any of the others; they are low crowned teeth (pl. I, figs. 14-17).

Measurements of teeth in millimeters.

	<i>a.</i>	<i>b.</i>	<i>c.</i>	<i>d.</i>
Height of crown				
at paracone.....	7.	7.5	7.	.....
Length on midline..	9.5	10.5	10.	9.
Mesostyle-hypo-				
cone width.....	13.	13.5	13.5	12.3

In all these teeth the transverse lophs are fully joined to the ectolophs. The protoconule is separated from the protocone by only a slight constriction; the metaconule similarly from the hypocone. The hypostyle rests on the rear cingulum and early coalesces with the metaloph and ectoloph. It is large, triangular, and not notched behind. The crochet is present in all the teeth except *d*. Where present, it is pressed against the protoloph, but has not coalesced with it. No enamel folds enter the fossettes. Through the union of the hypostyle with the metaloph the postfossette is early entirely closed.

The external styles are prominent; the intervening ribs low and rounded. The external cingulum is relatively strong; as are, too, the front and rear cingula along the protocone and the hypocone. The internal cingulum is obsolete. There appears to have been no cement.

A prominent character of these teeth is their breadth relative to the length of the crown. In Douglass's *Parahippus minimus* the length is about .70 of the width; in *P. minutalis*, only about .55 the width.

The writer estimates that the skull of this species was only about 8 inches long.

**Merychippus vellicans**, new species.

In the collection made in the Garvin gully are about a dozen upper molars which appear to belong to an undescribed form of *Merychippus*. Inasmuch as these are loose teeth, one is chosen as the type of the species. This is an upper left tooth believed to be a fourth premolar (pl. I, figs. 18, 19). It is worn only moderately. The measurements of this tooth are as follows:

Height of paracone.....	15. mm.
Height of protocone.....	8.5
Length of crown.....	15.
Width at base in front.....	20.5

The protocone is on the point of joining the protoconule, and this has united with the ectoloph. The hypocone has joined the metaconule; and the latter, the ectoloph. The crochet is pressed against the protoloph, but the enamel of both separates them. From the metaloph two enamel folds enter the pefossette, and one has pressed into the postfossette.

The protocone is broadly pyriform and is larger than the hypocone. The abraded hypostyle sends an enamel fold into the postfossette and another joins the metaloph. The outer cingulum is weak and the others are obsolescent. The outer styles are well developed; the anterior is rather broad. The ribs between the styles are low and rounded. There is a lining of cement in the fossettes, but these are not filled. A rather thin layer of cement covers portions of the external walls.

A series of three teeth (pl. I, figs. 20, 21) believed to be the second, third, and fourth premolars, but possibly belonging to as many individuals, is described and figured. They represent different stages of wear.

Measurements of upper premolars in millimeters.

	Pm <sup>2</sup>	Pm <sup>3</sup>	Pm <sup>4</sup>
Length.....	19.	15.5	15.1
Width of base.....	18.	18.6	20.9
Height of paracone.....	8.	16.5	18.0

From the protocone of the second premolar some enamel is missing. In this tooth the protocone has fully united with the protoconule, but between this and the ectoloph there is a thin notch. The inner valley opens out into the pefossette, but the way is obstructed by a little ring of enamel. The hypostyle is broadly connected with the metaloph.

The third premolar is less worn. The crochet, the protocone, and the protoconule are in close contact, but separated by their enamel. The metaloph sends two folds into the pefossette. The triangular hypostyle is not abraded, but joins the metaloph nearly to its summit. The fourth premolar has not been affected by wear. All its surface is thinly covered with cement. Occasionally an upper tooth is found which has the caballine fold.

Most of the 50 loose molars and premolars sent by Doctor Francis appear from their size, degree of hypsodonty, and development of cement, to belong to *Merychippus vellicans*. Three premolars of the right side are selected for description, pm<sub>2</sub>, pm<sub>3</sub>, pm<sub>4</sub> (pl. I, figs. 22). They may have belonged to as many individuals. The second premolar is worn somewhat; the third less; the fourth not at all.

Measurements of lower premolars in millimeters.

	Pm <sub>2</sub>	Pm <sub>3</sub>	Pm <sub>4</sub>
Height of crown on outside.....	8.8	14.5	17.5
Height of crown on inside.....	7.5	10.0	12.0
Length.....	16.0	14.5	16.0
Width.....	10.0	11.0	12.5

In the second premolar the metaconid and the metastylid form a single cusp. In the other the cusps are distinct; and on the inner face of the tooth a shallow groove separates them nearly to the base. The outer and the inner cingula are obsolete. On the front end a distinct cingulum starts at



the bottom of the protoconid and passes inward to the summit of the parastylid. At the rear end is a similar cingulum rising to the summit of the hypoconulid. All of these teeth are well cemented.

Figure 23 of plate I shows two left lower molars and figure 24 the same teeth, with the first molar.

Measurements of lower molars in millimeters.

	M <sub>1</sub>	M <sub>2</sub>	M <sub>3</sub>
Height of crown on outside.....	11.	15.	15.
Length.....	15.	16.5	19.
Width.....	12.	10.	9.

This species seems to be the most closely related to Osborn's *Merychippus isonesus primus* (Mem. Amer. Mus. Nat. Hist., n. s. vol. II, pt. 1, p. 104, figs. 2-4). It differs from that, however, in having lower crowned upper teeth, with two or three enamel folds entering the prefossette. Apparently, too, the enamel of the lower teeth in *M. isonesus primus* is much less complicated than in *M. vellicans*. Osborn's species is from the Arikaree formation, lower Middle Miocene, western Nebraska.

**Merychippus socius**, new species.

In the collection made in the Garvin gully are several upper molars which resemble in many respects the species here called *Miohippus vellicans*, but which differ so much that it seems best to regard them as belonging to a distinct species. Two of these teeth (pl. I, figs. 25, 27) appear to be second and third premolars; two others (pl. I, fig. 26) to be second and third molars. These four teeth are taken as the type of the species. They appear to have belonged to one individual, but this is not certain. These teeth differ from the corresponding ones of *M. vellicans* especially in being considerably shorter crowned. The four teeth figured are only moderately worn. The two premolars taken together are 32 mm. long; the two molars, 26.5 mm. The height of the metacone of the third premolar is 14 mm. That of the corresponding tooth of *M. vellicans*, in about the same stage of wear, is 16 mm. In *M. vellicans* the metaloph is uninterrupted from the first; in *M. socius* the hypocone is for a while distinct. In *M. vellicans* the metaloph sends at least two folds into the prefossette and one into the postfossette; in *M. socius* there is apparently only one in each, and these may be wanting.

**Merychippus francisi**, new species.

This species is based on teeth which were found by Dr. Mark Francis on the Noble farm.

Of teeth there is an upper which is taken to be a left first or second true molar (pl. I, figs. 28, 29) and this is made the special type of the species. There are also an upper right second premolar, the outer half of another upper molar or premolar, and a hindmost lower molar. It is not certain that any two of these teeth belonged to the same individual.

The type tooth, m<sup>1</sup> or m<sup>2</sup>, of the left side, is practically complete and only moderately worn. The height on the outer face is 22 mm., on the inner 15

mm. It is considerably curved and has a coat of cement. The fossettes too are filled with cement. The length of the crown is 15 mm.; the width 16 mm.

The structure of the tooth is an advanced one, not greatly different from that of *Equus*. The protocone is elongated, flat, and 7 mm. wide. There is no caballine fold in the median valley. At the front of the protocone is a notch but no loop of enamel. In the rear wall of the prefossette are two enamel folds, none in the front wall. Likewise in the postfossette are two folds in the anterior wall; none in the rear. The hypostyle is represented by a ring of enamel. The parastyle and mesostyle are prominent and thin. The corresponding ribs are low.

This tooth is somewhat smaller than the type of *M. severus* Cope. It is in a much more progressive stage of development.

The upper right second premolar (pl. II, figs. 1, 2) appears to be worn down about one-half of the height. The height at the rear of the outer face is 18 mm.; on the inner face, 10 mm. The length of the grinding face is 22.5 mm.; the width 19.5 mm. The protocone is circular and opens into the protoconule. In the rear wall of the prefossette is one deep fold and outward from this two shallow folds. In the rear wall is one deep fold. The median valley still opens into the prefossette.

The outer half of an upper molar (or premolar) is wholly unworn. It presents the thin sharp mesostyle, obsolescent ribs, and the fossettes filled with cement. The height of the crown on the outer face is 25 mm., the width at half the height, 16.5 mm. A fragment of another upper grinder presents the postfossette, the median valley, and part of the protocone. There is a distinct caballine fold.

A right lower molar or premolar is moderately worn. The height of the crown is 17 mm.; the length about mid-height is 15 mm.; the thickness 9 mm. Most of its surface is covered with cement. Where exposed, the enamel is provided with wrinkles directed up and down. The metaconid and the metastylid are separated by a distinct groove. The infolds from the inner face are deep. There is a distinct hypoconulid.

The left hindermost lower molar (pl. II, figs. 3, 4) is slightly worn. Its height is 22 mm.; the length 21 mm.; the thickness in front 7.5 mm. The metaconid and metastylid are separated by a deep groove. The infolds into the protoconid and the hypoconid are deep and complicated, quite as in *Equus*. The faces of the tooth are covered with cement.

#### **Procamelus leptognathus** Cope.

In the collection made on the Noble farm is a fragment of the right side of the lower jaw which contains the first and second molars. It seems necessary to refer this specimen to Cope's *Procamelus leptognathus*. This was described by Cope in 1893 (*Vert. Paleont. Llano Estacado*, p. 37), and was found in the Clarendon formation in northwestern Texas. Apparently no figure of the type has ever been published. Cope thought it uncertain that the species belonged to the genus *Procamelus*. Inasmuch as the upper incisors and premolars are not known and no limb bones, the species may belong to *Protolabis*.

The teeth of the specimen to be described (pl. II, fig. 5; pl. III, fig. 4) are in good condition and only moderately worn.

Measurements of molars in millimeters.

	M <sub>1</sub>	M <sub>2</sub>
Length of base.....	15.	20.
Length of grinding surface.....	18.	22.
Thickness at base.....	9.	10.2
Height on outer face.....	10.	13.

On the inner face the styles are weak and the ribs are low, broad and rounded. The jaw is slender. The depth at the front of the second molar is 23 mm. on the inner face; 19 mm. on the outer.

That part of Cope's description which may be applied to the specimen at hand runs as follows: "The mandibular ramus is remarkable for its slender proportions." "The crowns of the second and third true molars in both jaws are compressed. Vertical ridges are little marked on the internal side of the inferior molars." "Elevation of jaw at Mii, 23 mm." "Diameters inferior Mii, anterioposterior, 23 mm.; transverse at base, 12 mm."

*Procamelus concerptus*, new species.

The type specimen of this species is a part of the left horizontal ramus of a lower jaw (pl. IV, figs. 1, 2) found in the Fleming formation on the Garvin farm. It belonged to a young animal whose third permanent incisor had not yet appeared and which still retained the fourth milk molar. The first and second incisors and the last molar are not present. With the exception of the fourth milk molar, the teeth are only slightly worn. The following measurements are taken: The height is taken on the inner face.

Measurements of teeth in millimeters.

	C.	Pm <sub>1</sub>	Pm <sub>2</sub>	Pm <sub>3</sub>	Dm <sub>4</sub>	M <sub>1</sub>	M <sub>2</sub>
Height of crown.....	8.	10.	7.	7.	8.3	14.5	19.
Length of crown.....	8.5	9.	10.2	13.4	23.	21.3	25.
Thickness of crown....	3.4	5.	4.	6.	10.6	13.	15.

The third permanent incisor was ready to appear. It is a sharp blade, 11 mm. wide. The first and second permanent incisors probably fell out of their sockets after the death of the animal. The canine is convex on the outer face; the inner face has two grooves separated by a broad rib. The first premolar is convex on the outer face; less so on the inner. The fourth milk molar is three-lobed. The first and second molars have, on the inner faces, moderately developed styles and ribs. On the outer side the front and rear faces of each lobe meet to form a rather definite ridge. The first diastema is 21 mm.; the second, 18 mm. Measured on the inner face, the depth of the jaw just behind the first premolar is 19 mm.; below the first molar 29 mm. The mental foramen is in front of the first premolar. The symphysis was about 50 mm. long. Some of these measurements will probably be found greater in older specimens. The molars of this camel

differ from those referred to *Protolabis francisi* in being larger, thicker, and with less prominent ribs.

From the specimen here referred to *Procamelus leptognathus* the jaw described differs in being deeper; also the molars are longer and thicker and have better defined ribs on the inner faces. *Protolabis angustidens*, of the Pawnee Creek beds, Middle Miocene of Colorado (Cope and Matthew, Tertiary Mamm., etc., 1915, pl. CLIV, fig. 4), differs in greater inequality of length of the first and second molars. Also the second molar measures 30 mm. instead of 25 mm. as in *P. concerptus*.

*Procamelus gracilis*, of the Arikaree, Upper Miocene of Nebraska and South Dakota, as illustrated by Cope's figure of "*P. occidentalis*" (Wheeler's West 100th Merid., vol. IV, pl. LXXVII, fig. 3), later referred (Cope, Llano Estacado, 1893, p. 37) to *P. gracilis*, has the second molar longer (27 mm.  $\pm$ ) and thicker (17 mm.  $\pm$ ).

Inasmuch as only the lower jaw is present, it is possible that the species belongs to the genus *Protolabis*. It may be, too, that some of the limb bones in the Francis collection belong to the same species, but there is now no way of connecting them.

This camel was apparently about one-fifth larger than the llama, *Lama glama*.

#### ***Procamelus benedentatus*, new species.**

This species has for its type the nearly complete right ramus of a lower jaw containing the teeth, excepting the incisors and the canine; to it are referred also four loose lower molars. The jaw and the teeth were collected in the Garvin gully.

The ramus is preserved to the rear of the last molar (pl. V). The teeth are in good condition, except that a little is broken from the front of the third and the fourth premolars. The symphysis was not coössified.

#### Measurements of lower jaw and teeth:

	mm.
From incisive border to rear of $m_3$ .....	200
From incisive border to rear of alveolous of canine.....	30
From incisive border to rear of $pm_1$ .....	56
Length of symphysis.....	58
Depth of jaw on outer face at middle of diastema between $pm_1$ and $pm_2$ .....	26
Depth of jaw at front of $m_1$ .....	39
Depth of jaw at middle of $m_3$ .....	44
Length of $pm_2$ to $m_3$ inclusive.....	119
Length of $pm_2$ to $pm_4$ inclusive.....	38
Length of molars.....	79
Length of $m_1$ .....	20
Width of $m_1$ .....	14
Length of $m_2$ .....	23
Width of $m_2$ .....	16
Length of $m_3$ .....	35

Width of $m_3$ .....	16
Length of $pm_1$ .....	9
Thickness of $pm_1$ .....	6
Length of $pm_2$ .....	11
Thickness of $pm_2$ .....	5.5
Length of $pm_4$ .....	16
Thickness of $pm_4$ .....	10

A slightly worn  $m_2$  has the crown 17 mm. high. The anterior, median styles are moderately developed; the intervening ribs are about as in *Lama glama*.

This jaw resembles in many respects that of *Protolabis longiceps* (Matthew, Mem. Amer. Mus. Nat. Hist., n. s., vol. I, 1901, pp. 435-439, figs. 31-33), but Matthew's species lacks the first premolar. The same is true of Sinclair's *Protolabis princetonianus*. The lower molars of *Procamelus benedentatus* do not possess certain structures found in Cope's *P. fissidens* (Cope, Wheeler's Exped. W. 100th Merid., vol. IV, p. 328).

#### **Protolabis francisi**, new species.

In the collection made in the Garvin gully there are an ulno-radius, a remarkable third metacarpal bone, and the third and fourth metatarsals of a camel. There are likewise several teeth which are referred provisionally to the same camel. Inasmuch, however, as two species may be involved, it is to be understood that the metacarpal and the metatarsals form the type of the species, *Protolabis francisi* (pl. VI, figs. 1, 2).

The ulno-radius (pl. VI, fig. 3) belongs to the right side. The two bones are nearly complete, only some fragments missing in the shaft and at the distal end of the ulna. The two are as strongly consolidated as in the llama. On comparison with the same bones in the llama it is found that the fossil lacks only about 10 mm. in equalling in length that of the llama. That of the fossil is 345 mm. long, measured in a straight line. There is, however, a great difference between the bones of the two animals. The side-to-side diameter at the middle of the length of the fossil bone, is only about two-thirds that of the llama. The fore-and-aft diameter is about four-fifths that of the llama. The width of the greater sigmoid cavity is 40 mm. At the middle of the length the side-to-side diameter is 24 mm.; the fore-and-aft, 18 mm.

The metacarpal is that of an adult animal, inasmuch as the distal epiphysis is completely united to the shaft. The bone was nevertheless not co-ossified with the fourth metacarpal to form a cannon bone. The species appears therefore to belong to the genus *Protolabis*, although its proportions contravene one of the characters assigned as follows to *Protolabis* by Dr. W. D. Matthew (Mem. Amer. Mus. Nat. Hist., vol. I, 1901, p. 426):

"Metapodials separate, limbs and feet short and disproportionately small."

The metacarpal in question is 310 mm. long. The corresponding bone of a llama is 235 mm. long. Nevertheless the shaft of the bone in the fossil

camel has about the same diameters as that of the llama. There was then apparently in Fleming time either a *Protolabis* with long slender legs or a "split-footed" *Procamelus*. Future discoveries may solve the doubt.

The third metacarpal belongs to the right leg and is practically complete. It was originally in close contact with the fourth metacarpal, but was not ankylosed to it. A view of the surface in contact with the fourth metacarpal is presented (pl. VI, fig. 1). The side-to-side diameter at the middle of the length is 12.5 mm.; hence the diameter of the two bones was 25 mm. In the llama, at the same level the diameter is less, only 22.5 mm. The fore-and-aft diameter in the fossil is 26 mm.; in the llama, 21 mm. Relatively to the length the bone in the fossil is the slenderer. The diameter of the articulation with the third finger is 20 mm. wide in the fossil; 23.5 in the llama.

The left third and the fourth metatarsals, the elements forming in the recent camels the hinder cannon bone, are closely applied but not ankylosed. It appears probable that they belonged to the same individual as did the ulno-radius and the third metacarpal. The bones lack only unimportant fragments. At the rear of the upper end the process is broken off which rises between the cuboid and the middle cuneiform. The length of the combined bones is 300 mm.; that of the llama used for comparison, 230 mm. The side-to-side diameter at the middle of the length is 23 mm.; in the llama 20 mm. The fore-and-aft diameter at the same level is 23 mm. in the fossil; in the llama, the same. A broad groove occupies the whole length of the rear of the bone; a narrower one in front follows the line of junction between the two metatarsals.

In the collection are 6 proximal phalanges. One of these fits well with the distal ends of both the metacarpals and the metatarsals. The length of the bone is 73 mm. At the middle of the length the fore-and-aft diameter is 14 mm.; the transverse, 12 mm. Inasmuch as it is shorter than the same bone in the llama it is supposed to belong to the hinder foot. Another first phalanx has nearly the same length, but is more compressed. It probably belongs to another species. The other four phalanges are shorter and probably belonged to still another species.

Four lower molars are referred to this species and others probably belong to it. Three belonging on the left side are described and figured (pl. III, figs. 5-7). The third molar is too much worn to have belonged in the same jaw as the others. The following are the measurements. The whole series has a length of 58 mm., the same as those of a llama at hand. The measurements of the length are taken at half the height of the crowns and on the inner face. The width is taken at the base, the height on the outer face. All these teeth are only slightly worn.

Measurements of lower molars in millimeters.

	M <sub>1</sub>	M <sub>2</sub>	M <sub>3</sub>
Length.....	16.	17.	25.5
Width.....	10.2	12.2	11.5
Height.....	11.3	18.	15.

Another lower third molar is figured (pl. III, fig. 8). It belonged on the right side and is only slightly worn. The length is 25 mm.; the width, 11.1 mm.; the height, 20 mm. These teeth differ from those referred to *Procamelus leptognathus* in having less length, less thickness, but apparently greater height. The ribs on the inner face are more prominent and narrower.

This camel was evidently one having longer, slenderer legs than those of the llama. Doubtless, too, the body was of less heavy build and probably the neck was relatively longer. We may suppose that it was a fleet animal.

Besides the camel remains described above are parts of others not determinable. Some fragments of teeth are among these. There is a part of an ulno-radius whose side-to-side diameter at the middle of the length is nearly 40 mm.; also another intermediate in size between this and that of *Protolabis francisi*.

There is present from the Garvin gully also a right fourth metatarsal of a split-foot camel much smaller than that of *Protolabis francisi*. Its length exceeded by an unknown, but probably small amount, 255 mm. At the middle of the length the fore-and-aft diameter is 19.5 mm. A cervical vertebra of a camel is 135 mm. long.

#### *Dromomeryx texanus*, new species.

In the collection made on the Garvin farm are ten upper molars which appear to belong to *Dromomeryx* and to differ from those of any species heretofore described. Four of these teeth are figured (pl. II, figs. 8 to 12). Three (figs. 11, 10, 9 and 8) are regarded as the upper first, the second and the third molars of the right side. They probably belonged to as many individuals. At least, the first molar is too little worn to have belonged with the others. The third molar is taken as the special type of the species.

#### Measurements of molars in millimeters.

	M <sup>1</sup> (Fig. 11)	M <sup>2</sup> (Fig. 10)	M <sup>3</sup> (Figs. 8, 9)
Height of crown at paracone.....	9.5	7.	15.
Length of crown at middle of width.....	14.	16.	17.
Width of crown at base of front lobe....	15.	16.4	17.

The less height of the second molar is due to greater wear.

Another upper molar, probably the second, is illustrated (fig. 12). Its length is 17 mm.; width 18 mm.

The parastyles and mesostyles are prominent; the metastyle is moderately developed. The ribs are prominent. There are distinct anterior and posterior cingula, but none external or internal. There is, on the outer face of the first and the second molars, between the two lobes, a V-shaped cusp, but on the third molar is a single cusp adhering to the hinder lobe. The anterior horn of the hinder crescent is prolonged to the ectoloph. The hinder horn of the anterior crescent falls short of this. There are no folds

of enamel pushed into the fossettes. The enamel is minutely wrinkled. Although there are in the collection lower teeth which in size correspond to the upper molars described, they do not appear to possess the characters presented by those of other species of the genus.

These teeth appear to differ from those of *D. borealis* in having no folds of enamel in the fossettes, in being far more hypsodont, and smaller (Matthew, Bull. Amer. Mus. Nat. Hist., vol. XX, p. 128, fig. 21; Douglass, Ann. Carnegie Mus. vol. V, p. 467, pl. LXIII, figs. 1-3). Likewise the rib of the front lobe is much less prominent. They resemble the teeth of Douglass' figure 6, but are more rectangular in outline. Those teeth look as if they belonged to another species.

***Dromomeryx ? angustidens*, new species.**

In the collection made on the Garvin farm is a single right upper molar, apparently the hindermost, which appears to belong to an undescribed species of *Dromomeryx*, to be known as *Dromomeryx angustidens* (pl. II, figs. 6, 7). The tooth is little worn. The length at the middle of the width is 19 mm.; the width of the anterior lobe, 16.5 mm.; the height of the paracone 13 mm. There are prominent anterior and median styles, and rather prominent and narrow ribs. On the anterior and posterior faces are feeble cingula. There is no cusp between the lobes on the inner side. There are no folds of enamel projecting into the fossettes. At the rear of the hinder fossette is a groove which descends to the bottom of the fossette, and on the rear of the lobe, opposite the groove mentioned, is another.

This species seems to differ from others known in the relative narrowness of the molars, and it may belong to another genus.

***Blastomeryx vigoratus*, new species.**

In the collection made in the Garvin gully are 6 teeth which are thought to belong to hitherto undescribed species of *Blastomeryx*. The teeth included are as follows:

An upper right third molar unworn.

A lower right first molar in a fragment of the jaw.

Two lower left molars, the second and the third.

The two lower molars of the left side (pl. II, figs. 13, 14) are to be regarded as the type of the species. They are moderately worn. The right lower first molar (figs 15, 16) had just begun to be abraded; and it must have belonged to a younger animal than did the second and third.

Measurements of lower molars in millimeters.

	M <sub>1</sub>	M <sub>2</sub>	M <sub>3</sub>
Height of crown.....	6.	7.	6.3
Length of crown.....	10.	11.6	15.
Width of crown.....	6.3	7.6	7.

On the inner faces of the lower second and third molars the styles are feebly developed. The ribs are broad and projecting and they render the faces of the lobes strongly convex. On the outer faces the lobes are somewhat pointed, as seen on the worn surface. In the valley between the lobes



is a prominent cusp. On the anterior end of each of the molars is a distinct cingulum. The first molar presents no peculiarities. At the middle of this tooth the jaw is 7 mm. thick and 12 mm. high on the inner face; on the outer, 11.5 mm.

The upper molar (pl. II, figs. 17, 18) belongs on the right side and is believed to be the hindmost. It was just coming through the gum, and the roots were wholly unformed. The parastyle, mesostyle, and the intervening rib are prominent. The rib and the style on the metacone are feeble. The anterior lobe is pointed in horizontal section. The rear lobe is rounded. In the inner valley, between the lobes, is a small cusp. On the front end of the crown a cingulum crosses the anterior lobes and a feeble one is seen on the posterior lobe. The enamel of all these teeth is finely wrinkled.

The lower second and third molars of this species have nearly the size of those of *B. wellsi* (Matthew, Bull. Amer. Mus. Nat. Hist., vol. XX, 1904, p. 125, figs. 18, 19), found in the upper Miocene of South Dakota. The first molar is longer (11 mm.) and thicker (8 mm.) than in *B. vigoratus*. Matthew's species appears to differ from the Texas one also in having more hypsodont teeth. This difference does not seem to be wholly due to the greater wear of the Texas teeth. The two species are closely related.

In 1920, Matthew reported on a collection made in the Fleming formation, near Cold Spring, Jacinto County, Texas. Regarding a last lower molar he wrote as follows:

"This is apparently distinct from any known species, decidedly more progressive than those of the Lower Miocene, less so than the Upper Miocene species *B. wellsi*, more perhaps than the Middle Miocene species *B. gemmifer*."

It appears probable that the tooth thus described belonged to *B. vigoratus*.

#### ***Merycodus grandis*, new species.**

In the collection made on the Garvin farm are three fragments of antlers (pl. III, figs. 9-11) which appear to have belonged to a hitherto undescribed species of *Merycodus*. On account of the size of the antlers it is called *Merycodus grandis*.

The largest fragment (fig. 9) consists of a part of the beam and of one of the two branches into which it had divided; the other branch having broken off. The fragment is somewhat water-worn. In the description it is assumed that it is a part of the left antler. The beam is flatter on the outer side than on the inner. The fore-and-aft diameter is 20 mm.; the side-to-side, 16 mm. The hinder prong appears to have a base not greater than 15 mm. in diameter. The front prong is a little larger. The tip of this is missing, but about 30 mm. from the fork the diameter is reduced to 11 mm. The surface of this fragment is mostly without grooves.

A second fragment 42 mm. long (fig. 10) is oval in section. On one side are two grooves, soon branching into three. Other grooves are not so deep and broad. One diameter at the larger end is 18 mm.; the other 14.5 mm. A third fragment (fig. 11) is 50 mm. long and has deep grooves on one side.

At the larger end one diameter is 17 mm.; the other 14.5 mm. A fourth fragment, 40 mm. long, is in the collection made on the Noble farm.

DESCRIPTION OF PLATES.

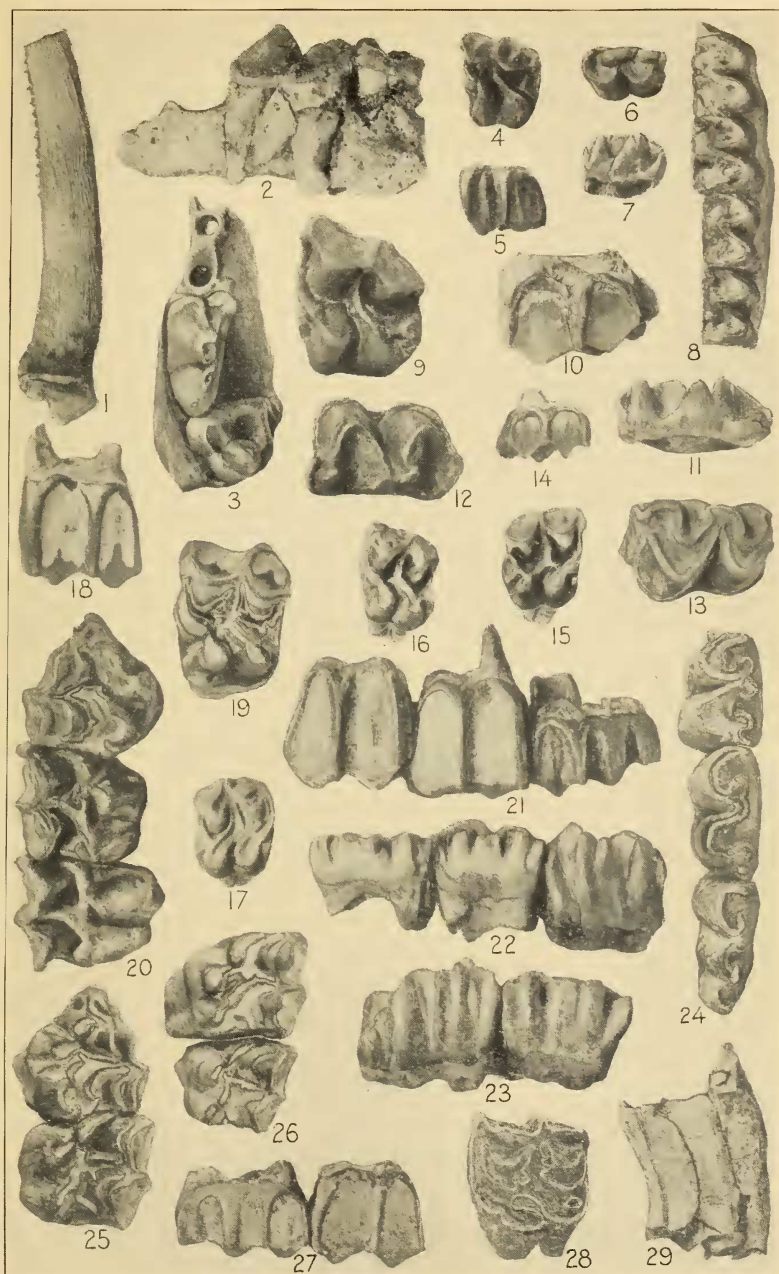
It is found that some of the figures vary slightly from the measurements given in the text.

PLATE I.

- Fig. 1. *Ameiurus? decorus*. Pectoral spine. Type.  $\times 1$ .  
 Figs. 2, 3. *Tephrocyon scitulus*. Upper jaw. Type.  $\times 1$ .  
 2. View from outside.  
 3. View of occlusal face.  
 Figs. 4-8. *Miohippus blackbergi*,  $\times 1$ .  
 4. Upper molar, occlusal face. Type.  
 5. Same molar. Outer face.  
 6. Referred lower left first molar, occlusal face.  
 7. Same tooth, inner face.  
 8. Referred right ramus with lower teeth, occlusal face.  
 Figs. 9-13. *Miohippus navasotae*,  $\times 1$ .  
 9. Upper left molar, occlusal view. Type.  
 10. Same tooth, outer face.  
 11. Lower left molar. Inside view.  
 12. Same tooth. Occlusal view.  
 13. Lower premolar. Occlusal view.  
 Figs. 14-17. *Parahippus minutalis*. Three upper teeth. Type.  $\times 1$ .  
 14. Molar *b*. Outer face.  
 15. Same tooth. Occlusal face.  
 16. Molar *a*. Occlusal face.  
 17. Premolar *c*. Occlusal face.  
 Figs. 18-24. *Merychippus vellicans*.  
 18. Upper left premolar. Outside view. Type.  $\times 1$ .  
 19. Same tooth. Occlusal view.  
 20. Referred upper right premolars. Occlusal faces.  
 21. Same teeth. Outer faces.  
 22. Referred lower right premolars, inner faces.  
 23. Referred lower left second and third molars, inner faces.  
 24. Same teeth, with first molar. Occlusal faces.  
 Figs. 25-27. *Merychippus socius*. Type.  $\times 1$ .  
 25. Second and third upper premolars. Occlusal faces.  
 26. Second and third upper molars. Occlusal faces.  
 27. Second and third premolars. Outer faces.  
 Figs. 28-29. *Merychippus francisi*.  
 28. Left upper molar. Occlusal face.  
 29. Same tooth. Front face.

PLATE II.

- Figs. 1-4. *Merychippus francisi*.  $\times 1$ .  
 1. Second premolar. Occlusal face.



Upper Miocene Vertebrates from Texas.